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FOREST INSECT INVESTIGATIONS

EXPERIMENTAL SPRAYING FOR THE CONTROL OF THE SPRUCE BUDWORM IN THE CODY CANYON, SHOSHONE NATIONAL FOREST 1932

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Introduction

During the past ten years there has been a serious destruction of the scenic Douglas-fir forests of the Cody Canyon resulting from a persistent outbreak of the spruce budworm (Cacoecia fumiferana). The experimental spraying for the protection of trees within this region with high scenic values, which was instituted in 1930, was continued during the past season on a very small scale. This report, which will be made as brief as possible, will include the results of last season's spraying operation, the present status of the spruce budworm epidemic, and its relation to the Douglas-fir beetle outbreak that is now present within the defoliated areas of the region. For more detailed information relative to the past history of this project, reference is made to previous reports[1].

EXPERIMENTAL SPRAYING OPERATION

1931 Project

To complete the picture of last season's operation, it is necessary to mention briefly the 1931 project. During this project, which was

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Evenden, J. C. 1930. Experimental Spraying for Control of the Spruce Budworm in the Cody Canyon Shoshone National Forest. March 24.
Evenden, J. C. 1931. Experimental Spraying for the Control of the Spruce Budworm in the Cody Canyon, Shoshone National Forest, 1930. February 20.
Miller, E. E. 1933. Notes on 1932 Spraying in Cody Canyon, Spruce Budworm. February 9.

planned on an extensive experimental basis, some 69,400 gallons of spray were applied at a cost of $1,478.33. All trees around the "Dude Ranches" and summer homes were treated with a standard lead arsenate-fish oil spray which was believed to be the best treatment known. In addition to the treatment of these areas as a direct control measure, 22 sample plots were established that were treated with different sprays[2].

Though variable results were secured from these experiments, there was very little difference in the maximum defoliation of the treated portion of each plot and that part left as a control upon the experiment. Such data seemed to indicate that the sprays used were not a great deal more effective than the natural mortality that had occurred on the untreated trees adjacent. In 1930 it was predicted that the outbreak was at an end. Judging from the light infestation of the 1931 season there seemed to be no further question but that the outbreak of this insect was at an end, and that there would not be a great deal of defoliation in 1932.

1932 Spraying Operation

At the close of the 1931 operation there was a small quantity of lead-arsenate (1250#) and fish-oil (50 gal.) remaining. Though there was no special appropriation for the continuance of this project in 1932, it was planned to use the available material in treating the trees at any of the "Dude Ranches" where the 1932 infestation was considered as being sufficiently heavy to cause a serious defoliation. In making this recommendation, it was fully recognized that the present treatment is only partially effective in destroying the feeding larvae of this insect. How-

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2 Evenden, J. C. 1932. Experimental Spraying for the Control of the Spruce Budworm in the Cody Canyon, Shoshone National Forest, 1931. March 15.

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over, it was believed that such action would be a justifiable one, as it was possible that the results secured would be sufficient to preserve any valuable trees that might be threatened by severe defoliation.

An examination of the "Dude Ranches" was made during June in order to determine the need for treatment. It was with surprise that the infestation on nearly all areas examined was found to be far more severe than that which existed in 1931. To meet this unforeseen situation, financial cooperation was extended by the "Dude Ranch" owners for the purchase of an additional supply of lead-arsenate and fish-oil, labor was provided by the Bureau of Entomology, and with additional labor contributed by the Forest Service and private owners, all of the seriously infested resorts were treated.

The following table shows the areas treated during the 1932 operation. These trees were thoroughly sprayed at a time when the foliage was thought to be in the best possible condition, and under favorable weather conditions. The results which were secured are believed to be the very best that can be expected from this treatment. Detailed examinations were not considered as being necessary; however, they were carefully observed and data depicting the general status of the results secured are shown in the following table:

Formula - Lead-arsenate 6#, Fish-oil 1 qt., Water 100 gal.

Area sprayed	Date of 1932 spraying	Amt. of spray used (gal.)	Cover-age	Total 1931 defoli-ation	Defoliation: at time of: 1932 spraying	Total 1932 defoli-ation
Blackwater	June 22	2,400	Fair	62%	12%	50%+
Elephant Head	June 23	1,200	Poor	15%	12%	25%
Absoraka	June 23	2,400	Fair+	62%	37%	62%
Holm Lodge	June 24-26	7,800	Fair	50%	25%	50%
Artist Colony	June 26-27	3,000	Good	50%	25%	50%
Powell Colony	June 27-28	7,400	Fair	62%	37%	62%
Crouch's	June 28	1,200	Poor	62%	25%	62%

From the above table it will be seen that on the treated areas there has been but little change in the degree of defoliation during the past two seasons. Though the data as given are not questioned, there are other factors which discolor the picture as drawn. The defoliation figure refers to the entire area surrounding each "Dude Ranch", and not to individual groups of trees which may possess the greatest scenic value to the property at stake. In 1932, trees of such value that had heretofore been spared from heavy defoliation were seriously injured, causing a situation which to the resort owners appeared more alarming than at any other time during the outbreak.

Though the preceding table gives the status and degree of defoliation for the "Dude Ranches", it does not depict the status of the infestation outside of the areas sprayed in 1932. Instead of the predicted decline, a marked increase in the severity of the defoliation occurred throughout a very large per cent of the infested area. No reason can be given for

this increase, when both the history of similar outbreaks and actual existing field conditions the previous season indicated that the outbreak was at an end. Though one can say that this unforeseen increase was due to the breaking down of some environmental factor that had previously exerted sufficient influence to produce a temporary reduction, the explanation is intangible and the question remains unanswered. Under present conditions one can not foresee the future of this outbreak; however, if a prediction could be based upon the number of adult moths that were present within the area last July, an extremely severe defoliation can be expected during the 1933 season.

Experimental Spraying 1932

During the 1932 operation an experimental plot was established at Powell Colony to test the effectiveness of a commercial product called Forestit. This material was purchased the previous season but had not been received in time for use during that operation.

Two small plots were used for this test, and two different-strength formulae used.

Powell Colony Plot #1

Spray applied - June 28, 1932.

Formula - Forestit 16#, fish-oil 4 qts., water 400 gallons.

Foliage - Buds all open.

Weather - Warm to hot - very little wind.

Amount of spray used - 400 gallons.

July 26, 1932 - Final examination to determine the results secured from the application of this spray was made from new-growth tips from 2 treated and 1 untreated tree. Trees were carefully selected as representative of

the entire plot.

Comparison of Tips Injured on Sprayed and Unsprayed Trees

Degree of injury		Defoliation of trees before spraying	Total defoliation of sprayed trees	Total defoliation of unsprayed trees
0	No. of tips	455	214	129
	% of tips	72.6	35.6	22.6
12.5%	No. of tips	106	97	29
	% of tips	16.9	16.1	5.0
37.5%	No. of tips	30	95	41
	% of tips	4.7	15.8	7.1
62.5%	No. of tips	19	69	22
	% of tips	3.0	11.5	3.8
87.5%	No. of tips	16	125	347
	% of tips	2.5	20.8	60.8
Total tips		626	600	568
Average per cent of injury		8.0	33.3	59.2

From the above teble it will be seen that at the time this plot was treated an 8% defolistion had occurred. By July 26, at which time all feeding for the season being over, the defoliation of the untreated trees had reached a maximum of 59.2%. However, on the treated trees this injury had been reduced to 33.3%. If the degree of defoliation at the time of treatment is taken from the maximum defoliation of both the treated and untreated trees, there is a defoliation, following treatment, of 25.3% for the treated and 51.2% for the untreated trees. From these figures the spray as applied would appear to have been practically 50% effective in reducing the amount of defoliation following the treatment. Due to variation in the foliage development it would be impossible to treat the trees at a time when no previous defoliation had occurred.

Powell Colony Plot #2

Spray applied - June 28, 1932.

Formula - Forestit 3#, fish-oil 8 qts., water 400 gallons.

Foliage - Buds all open.

Weather - Hot - very little wind.

Amount of spray used - 400 gallons.

Comparison of Tips Injured on Sprayed and Unsprayed trees

Degree of injury		Defoliation of trees before spraying	Total defoliation of sprayed trees	Total defoliation of unsprayed trees
0	No. of tips	412	164	129
	% of tips	66.4	26.8	22.6
12.5%	No. of tips	75	64	29
	% of tips	12.0	10.4	5.0
37.5%	No. of tips	60	193	41
	% of tips	9.6	31.6	7.1
62.5%	No. of tips	43	71	22
	% of tips	6.9	11.6	3.8
87.5%	No. of tips	30	118	347
	% of tips	4.8	19.3	60.6
Total tips		620	610	568
Average per cent of injury		13.6	37.3	59.2

From the above table it will be seen that at the time this plot was treated the trees were 13.6% defoliated. On the unsprayed trees this injury increased to 59.2% by July 26, which can be considered as the maximum defoliation, while on the treated trees the defoliation was reduced to 37.3%. By following the same procedure as used for Plot #1, this treatment would also appear to be only 51.9% effective, even though a double strength of Forestit was used.

Ovicide Experiment 1931

During the 1930 project it was thought that if an ovicide was applied to the trees during oviposition the eggs would be destroyed and subsequent defoliation prevented. It was fully realized that oviposition extended over a longer period than that required for incubation, and that the first eggs would be hatched before the last were deposited. This condition would make it necessary to spray at shorter intervals than the period of incubation if all of the eggs were to be destroyed. However, it was believed that it might be possible to apply one treatment at a time when a maximum number of eggs would be destroyed and the subsequent defoliation minimized. Though a test of this possibility was made in 1930, without any evident success, two additional plots were established during the 1931 operation. Egg masses were collected from the treated and untreated trees, and closely observed in order to record the per cent of mortality secured.

Plot 21

July 24, 1931 - Plot sprayed.

Formula - Lead-arsenate 8#, Volck 12 gallons, water 400 gal., 3% Volck solution.

Date of egg mass collection	Number of egg masses collected	Number egg masses hatched	Per cent of egg masses hatched	Reduction in the infestation
July 27, 1931	70	July 27-August 15 11 egg masses hatched	15.7%	84.3%
July 31, 1931	162	July 31-August 15 18 egg masses hatched	11.1%	88.9%
Total	232	29	12.5%	87.5%
Reduction Netural Causes 23.7%	55			
Living egg masses	177	29	16.4%	83.6%

Plot 22

July 24, 1931 - Plot sprayed.

Formula - Lead-arsenate 12#, nicotine sulphate 2 qts., water 400 gallons.

Date of egg mass collection	Number of egg masses collected	Number of egg masses hatched	Per cent of egg masses hatched	Reduction in the infestation
July 25, 1931	59	30	51%	49%
July 31, 1931	57	45	79%	21%
Total	116	75	64.6%	35.4%
Reduction natural causes 23.7%	27			
Living egg masses	89	75	84.2%	15.8%

Unsprayed Check plot

Date of egg mass collection	Number of egg masses collected	Number of egg masses hatched	Per cent of egg masses hatched	Natural reduction in infestation
July 25, 1931	69	50	72%	28%
July 31, 1931	24	21	87%	13%
Total	93	71	76.3%	23.7%

As a result of these tests it would seem that rather fair results were secured with the 3% Volck solution. Though 87.5% of the egg masses were destroyed as a result of this treatment, in actual practice this figure would be reduced somewhat by the natural mortality of the eggs as shown in the check plot. From these data it will be seen that a natural mortality in the egg masses of 23.7% exists. When this figure is applied to the results of the two treatments, the per cent of reduction is reduced from 87.5% to 63.8% for the Volck, and from 35.4% to 15.8% for the nicotine sulphate.

Field examinations were made of these two plots on July 13, 1932, to determine if there was any difference in the defoliation of the treated trees and that portion of the plot left as a control upon the experiment. From the foregoing data it will be seen that the examination of egg masses showed an 83.6% mortality for the Volck treatment, and it was expected that the effects of such a mortality could be seen in the subsequent seasons defoliation. Though no detailed data were taken, the examination was made as thorough as possible. Trees from the treated and untreated portions of each plot were compared to show the difference in the defoliation. Though it is possible that the figures as given are not exactly accurate, the picture as drawn is correct.

From the above examination it was estimated that the 1932 defoliation on both plots averaged approximately 75%, and that there was no difference in the injury of treated and untreated trees. This is rather difficult to explain, as the 83.6% mortality to the egg masses from the plot treated with Volck, would seem to be sufficient to evidence itself in the subsequent years defoliation. It is possible that at the time these trees were treated that the maximum period of oviposition had not been reached.

Cost of 1932 Spraying Operation

As previously stated, a large portion of the materials used during the 1932 operation were left from the previous season. In order to augment this supply, which was not sufficient to treat all of the areas, a small additional amount was purchased by the resort owners. In addition to this outlay of money, further assistance was given to this operation through the donation of labor. The following tables summarize the cost of the spraying operation for the past three seasons:

Items	1930	1931	1932
Cost of project	$5,670.65	$1,478.33	$633.95
Amount of spray used (gallons)	136,000	69,400	25,400
Cost per gallon of spray	$ .00416	$ .000213	$ .0025
Man days (exclusive of overhead)	374	107	41.8
Gallons of spray per man-day	364	648	606
Cost to project per man-day	$ 15.16	$ 13.81	$ 15.21

Analysis of Costs of 1932 Operation

Supervision (Salary & Expenses)		$168.75
Labor (For applying spray)		
Paid by Bureau of Entomology - 24.85 Man-Days -	$90.85	
Contributed by Forest Service - 6.5 " " -	25.00	
Contributed by "Dude Ranch" owners - 11 " "	35.75	
	151.60	151.60
Spray Materials		
Hold-over from 1931 project	166.50	
Donated by private owners	117.10	
	283.60	283.60
Gasoline for Ford truck (Bureau Entomology)		30.00
		$633.95

1932 Crew Organization

Bureau of Entomology
- 1 Nozzleman ..... $4.00 per day
- 2 Hosemen ..... 3.25 " "
- 1 Truck driver & overhead .. Contributed

Forest Service
- 1 Hoseman ..... Contributed

Dude Ranch Owners
- 1-3 Hosemen ..... Contributed

PLANS FOR THE 1933 SEASON RELATIVE TO SPRUCE BUDWORM CONTROL

Though this project has rather forcefully demonstrated the ineffectiveness of present methods of control against the spruce budworm, it is believed by many that the reduction secured from such treatment has been sufficient to preserve the trees around the "Dude Ranches" and resorts for which protection was especially desired. A small allotment of $500.00 has been made by the Forest Service for the 1933 season, which with contributed labor will permit the treatment of approximately the same areas as covered in 1932. The Bureau of Entomology will assume the responsibility for the application of this spray, and will contribute the salary and expenses of Bureau officers assigned to this operation. It is planned to treat the following areas during the 1933 operation:

Area	Number of 600-gallon tanks of spray
Holm Lodge	17
Black Water	5
Absoraka	4
Elephant Head	3
Powell Colony	11
Rumseys	4
Artist Colony	7
	51

30,600 gallons of spray.

INTERRELATION OF BUDWORM AND BARK-BEETLE INFESTATIONS

In addition to the spruce budworm epidemic the situation within the Cody Canyon is complicated by an outbreak of the Douglas-fir beetle attacking previously defoliated stands of Douglas fir. Though the presence of these beetles had been known for some time, the seriousness of their attacks was not realized until the summer of 1931, when they began to attack fairly healthy trees at the Blackwater Dude Ranch. Control measures were instituted in the fall of 1931 to combat this secondary insect offensive, and some 12,000 trees were treated at a cost of $11,900. As a result of this operation, a reduction in the infestation of 52% was secured on all of the areas treated. This project was again instituted in 1932 and approximately 8250 trees treated at a cost of $7,900. The results of the 1932 project which included a number of new areas, will not be available until the summer of 1933.

The associated budworm and bark-beetle epidemics present a very complicated situation which is difficult to analyze. The bark-beetle outbreak undoubtedly developed from the tremendous volumes of favorable host material produced by budworm defoliation. Many trees were attacked by beetles, from which all foliage had been destroyed by budworms and which could not have recovered. There can be no question but that healthy forest conifers are destroyed by severe defoliation alone. With this knowledge there would be no object in controlling the bark-beetle outbreak if the budworm defoliation continued in its present severe destructiveness.

Bark-beetle control was instituted in the fall of 1931 on the premise that the budworm outbreak was at an end. Such action was justified as there was no question but that the bark-beetle outbreak was of

such magnitude that unless checked severe destruction of valuable trees was bound to follow. The unexpected increase in the severity of the budworm defoliation placed future bark-beetle control in a hazardous position. If the budworm outbreak continues, the trees for which protection is especially desired will be destroyed through this agency. If, however, such defoliation only continues for another year or two the trees will be spared from budworm destruction, but if the beetles are allowed to develop into a severe epidemic there will be no question but that large numbers of them will be destroyed. On one hand there is the question as to the life of the budworm epidemic, with the knowledge that several years defoliation will destroy the trees. On the other there is rather positive assurance that, regardless of the future of the budworm outbreak, the beetles, if allowed to continue unchecked, will destroy timber stands of high scenic values.

This complex situation made the institution of bark-beetle control in the fall of 1932 a very uncertain procedure. However, it was instituted on a hopeful basis that the budworm epidemic would soon die down and not of itself destroy the trees preserved through the control of the beetles. However, it must be recognized that as long as the budworms continue to provide volumes of weakened timber through defoliation there will continue to be bark beetles within the area. Bark-beetle control must of a necessity be projected on the basis of reducing the present outbreak to as near a normal condition as possible, which must be maintained until the weakened host material has been eliminated. As has been stated, it was believed that in the fall of 1931 the end of the budworm outbreak was in sight; with its revival in 1932, the future is unknown.

A situation exists which must be carefully studied and decision as to future control reached only after a careful analysis of the 1933 data has been made.

Respectfully submitted,

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Entomologist.